

AMENDMENT

Serial No. 10/774,298

Docket No. VEL03-GN003

In the Claims:

1. (CURRENTLY AMENDED) A chemical process system comprising:

a first unit operation comprising microchannels adapted to be in fluid communication with an inlet stream and an outlet stream for carrying out a continuous process;

a pressure vessel at least partially containing the first unit operation therein, the pressure vessel concurrently adapted to be occupied by an inert medium to compress the microchannels of the first unit operation; and

a purge stream adapted to be in fluid communication with an inert medium source for selectively conveying the inert medium from the inert medium source and into fluid communication with the first unit operation;

where at least a portion of the microchannels are isolated from an interior of the pressure vessel.

2. (ORIGINAL) The chemical process system of claim 1, wherein the first unit operation includes a chemical reactor.

3. (ORIGINAL) The chemical process system of claim 1, further comprising a second unit operation in thermal communication with the first unit operation.

4. (ORIGINAL) The chemical process system of claim 3, wherein the second unit operation includes at least one of a heat exchanger and a chemical reactor.

5. (CURRENTLY AMENDED) The chemical process system of claim 3, wherein ~~at least one of the first unit operation and~~ the second unit operation includes microchannels.

6. (ORIGINAL) The chemical process system of claim 2, wherein:

the chemical reactor includes microchannels;

the inlet stream includes a first reactant stream; and

the outlet stream includes a first product stream.

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7. (ORIGINAL) The chemical process system of claim 1, wherein the first unit operation is at least one of cooled and heated at least in part by the inert medium.
8. (ORIGINAL) The chemical process system of claim 1, wherein the inert medium includes at least one of helium, neon, argon, krypton, xenon, and nitrogen.
9. (ORIGINAL) The chemical process system of claim 1, wherein the inert medium includes water.
10. (ORIGINAL) The chemical process system of claim 6, wherein the microchannels include a catalyst.
11. (ORIGINAL) The chemical process system of claim 10, wherein the catalyst comprises at least one of a catalytic lining, a catalytic pellet, and a catalytic insert.
12. (ORIGINAL) The chemical process system of claim 1, wherein the inert medium within the pressure vessel is adapted to be in fluid communication with at least one of a heat exchanger, a pump, a compressor, and an inert medium source.
13. (ORIGINAL) The chemical process system of claim 1, further comprising a controller operatively coupled to a first sensor monitoring an internal pressure within the pressure vessel and a second sensor monitoring an internal pressure within the first unit operation, wherein the controller is responsive to data generated by the first sensor and the second sensor to operate the pressure vessel at a higher pressure than the first unit operation.
14. (ORIGINAL) The chemical process system of claim 13, wherein the controller is operatively coupled to a vent valve in fluid communication with the pressure vessel to

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selectively vent at least a portion of the inert medium within the pressure vessel to decrease the internal pressure within the pressure vessel.

15. (ORIGINAL) The chemical process system of claim 13, wherein the controller is operative to detect a leak within the first unit operation from the data generated by at least one of the first sensor and the second sensor.

16. (ORIGINAL) The chemical process system of claim 5, wherein the second unit operation is at least partially contained within the pressure vessel.

17. (CURRENTLY AMENDED) A chemical process system comprising:
a first unit operation including microchannels adapted to be in fluid communication with an inlet stream and an outlet stream;
a second unit operation in thermal communication with the first unit operation;
and
a pressure vessel at least partially containing the first unit operation therein and adapted to be concurrently occupied by a compressive medium adapted to maintain the first unit operation in compression;
where at least a portion of the microchannels are isolated from an interior of the pressure vessel.

18. (ORIGINAL) The chemical process system of claim 17, wherein the second unit operation includes at least one of a heat exchanger and a chemical reactor.

19. (ORIGINAL) The chemical process system of claim 18, wherein the second unit operation includes a chemical reactor adapted to be in fluid communication with a reactant stream and a product stream.

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20. (ORIGINAL) The chemical process system of claim 19, wherein the second unit operation also includes a heat exchanger facilitating thermal energy transfer between the second unit operation and the first unit operation.

21. (ORIGINAL) The chemical process system of claim 18, wherein the second unit operation includes a heat exchanger facilitating thermal energy transfer between the second unit operation and the first unit operation.

22. (ORIGINAL) The chemical process system of claim 17, further comprising a purge stream adapted to be in fluid communication with the compressive medium and in selective fluid communication with the first unit operation.

23. (ORIGINAL) The chemical process system of claim 17, wherein:
the first unit operation includes at least one of a chemical reactor, a heat exchanger, a mixer, and a separation unit; and
the second unit operation includes at least one of a chemical reactor, a heat exchanger, a mixer, and a separation unit.

24. (ORIGINAL) The chemical process system of claim 23, wherein the pressure vessel at least partially contains the second unit operation.

25. (ORIGINAL) The chemical process system of claim 24, wherein:
the second unit operation includes microchannels; and
the first unit operation and the second unit operation are coupled together in a single microchannel module.

26. (ORIGINAL) The chemical process system of claim 25, wherein:
the first unit operation includes a chemical reactor;
the first unit operation includes a catalyst in series with the microchannels thereof;
and

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the catalyst comprises at least one of a catalytic lining, a catalytic pellet, and a catalytic insert.

27. (ORIGINAL) The chemical process system of claim 26, wherein:

the second unit operation includes a chemical reactor;

the second unit operation includes a catalyst in series with the microchannels thereof; and

the catalyst comprises at least one of a catalytic lining, a catalytic pellet, and a catalytic insert.

28. (ORIGINAL) The chemical process system of claim 25, wherein the pressure vessel at least partially contains a plurality of microchannel modules therein.

29. (ORIGINAL) The chemical process system of claim 25, wherein:

at least one of the microchannels of the first unit operation and the microchannels of the second unit operation include a catalyst in series therewith; and

the microchannels at least one of upstream of the catalyst and downstream from the catalyst comprise a heat exchanger.

30. (ORIGINAL) The chemical process system of claim 29, wherein:

the microchannels of the first unit operation and the second unit operation each include a catalyst in series therewith; and

the microchannels of the first unit operation and the second unit operation at least one of upstream of the catalyst and downstream from the catalyst each include a heat exchanger.

31. (ORIGINAL) The chemical process system of claim 30, wherein the microchannels of the first unit operation are adapted to carry a first fluid in a first direction and the microchannels of the second unit operation are adapted to carry a second fluid in a second direction, opposite the first direction.

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32. (ORIGINAL) The chemical process system of claim 25, further comprising a controller to regulate an internal pressure within the pressure vessel.

33. (ORIGINAL) The chemical process system of claim 17, wherein the pressure vessel includes a recycle stream for cycling the compressive medium into and out of the pressure vessel.

34-47. (CANCELLED)

48. (WITHDRAWN) The chemical process system of claim 1, wherein:

the pressure vessel is in selective fluid communication with an inert medium source; and

a controller operatively coupled to at least a first system sensor detecting an internal pressure within the first unit operation and a second system sensor detecting an internal pressure within the pressure vessel, the controller being responsive to data generated by the first system sensor and the second system sensor to adjust the internal pressure within the pressure vessel.

49. (WITHDRAWN) The chemical process system of claim 48, wherein the first unit operation includes a plurality of microchannels in which at least a portion of a chemical reaction takes place.

50. (WITHDRAWN) The chemical process system of claim 48, further comprising a second unit operation in thermal communication with the first unit operation.

51. (WITHDRAWN) The chemical process system of claim 50, wherein:

the second unit operation includes microchannels therein; and

the microchannels of the second unit operation are coupled to the microchannels of the first unit operation to provide an integrated module.

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52. (WITHDRAWN) The chemical process system of claim 48, wherein:
- the pressure vessel includes an integrated module at least partially housed therein;
 - the first unit operation includes a chemical reactor;
 - the second unit operation includes at least one of a chemical reactor and a heat exchanger;
 - the chemical reactor of the first unit operation is housed within the pressure vessel; and
 - at least one of a chemical reactor and a heat exchanger of the second unit operation are housed within the pressure vessel.
53. (WITHDRAWN) The chemical process system of claim 48, wherein
- the controller is operatively coupled to a control valve in fluid communication with the inert medium source and upstream from the pressure vessel to selectively provide the inert medium to the vessel and increase the internal pressure therein in response to data received from the first sensor and the second sensor; and
 - the pressure vessel includes an outlet stream including a vent valve in series therewith to vent excess pressurized inert medium from the pressure vessel.
54. (WITHDRAWN) The chemical process system of claim 48, wherein the pressure vessel includes a purge valve in series therewith, operatively coupled to the controller, and in selective fluid communication with the first unit operation.
55. (WITHDRAWN) The chemical process system of claim 48, wherein the second unit operation includes a chemical reactor in thermal communication with the chemical reactor of the first unit operation.
56. (WITHDRAWN) The chemical process system of claim 55, wherein the first unit operation includes a heat exchanger comprising microchannels at least one of upstream and downstream from the chemical reactor of the first unit operation, and the second unit

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operation includes a heat exchanger comprising microchannels at least one of upstream and downstream from the chemical reactor of the second unit operation in thermal communication with the heat exchanger of the first unit operation.

57. (WITHDRAWN) The chemical process system of claim 48, wherein:

the pressure vessel includes a recycle stream; and

the recycle stream is in series with at least one of a compressor, a pump, a condenser, and a heat exchanger.

58. (WITHDRAWN) The chemical process system of claim 48, wherein the pressure vessel includes at least one refurbishment line to refurbish a catalyst in series with a chemical reactor of the first unit operation.

59. (WITHDRAWN) The chemical process system of claim 48, wherein:

the inert medium within the pressure vessel is in selective fluid communication with a chemical reactor of the first unit operation.

60. (WITHDRAWN) The chemical process system of claim 48, wherein: the first unit operation includes a first microchannel module comprising microchannels, in which at least a portion of a unit operation takes place, adapted to be in fluid communication with the inlet stream and the outlet stream; and

the pressure vessel at least partially contains a second unit operation including microchannels adapted to be in thermal communication with the first unit operation, the second unit operation adapted to be in fluid communication with a second inlet stream and a second outlet stream.

61. (WITHDRAWN) The chemical process system of claim 60, wherein:

at least one microchannel of the first unit operation is adjacent to at least one microchannel of the second unit operation and in thermal communication therewith;

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at least one of a chemical reactor, a mixer, a chemical separation unit, and a heat exchanger includes the at least one microchannel of the first unit operation; and

at least one of a chemical reactor, a mixer, a chemical separation unit, and a heat exchanger includes the at least one microchannel of the second unit operation.

62. (WITHDRAWN) The chemical process system of claim 61, wherein:

the first unit operation includes a chemical reactor including the at least one microchannel;

the at least one microchannel of the first unit operation includes a catalyst in series therewith; and

the catalyst comprises at least one of a catalytic lining, a catalytic pellet, and a catalytic insert.

63. (WITHDRAWN) The chemical process system of claim 62, wherein:

the chemical reactor of the first unit operation houses the catalyst therein;

the at least one microchannel of the first unit operation is adjacent to the at least one microchannel of the second unit operation; and

the at least one microchannel of the first unit operation is adapted to carry a first fluid therein in a first direction and the at least one microchannel of the second unit operation is adapted to carry a second fluid in a second direction.

64. (WITHDRAWN) The chemical process system of claim 63, wherein:

the pressure vessel is generally cylindrical in shape; and

the first microchannel module is generally rectangular in cross-section.

65. (WITHDRAWN) The chemical process system of claim 60, wherein at least one of the first unit operation and the second unit operation is in fluid communication with an open atmosphere.

66. (WITHDRAWN) The chemical process system of claim 60, wherein:

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the first unit operation includes a first chemical reactor adapted to receive a first reactant feed via the inlet stream;

the second unit operation includes a second chemical reactor adapted to receive a second reactant feed via the second inlet stream;

the first chemical reactor and the second chemical reactor are adapted to be maintained in compression by the inert medium within the pressure vessel; and

the first microchannel module comprises a plurality of laminated sheets.

67. (WITHDRAWN) The chemical process system of claim 17, wherein:

the first unit operation includes a first chemical reactor including microchannels adapted to be in fluid communication with a first reactant stream and a first product stream;

the second unit operation includes a second chemical reactor including microchannels adapted to be in thermal communication with the first chemical reactor, wherein the microchannels of the second chemical reactor are adapted to be in fluid communication with a second reactant stream and a second product stream; and

the pressure vessel is adapted to be concurrently occupied by a compressive medium in thermal communication with the first chemical reactor.

68. (WITHDRAWN) The chemical process system of claim 67, wherein the compressive medium includes water and the pressure vessel is an elevated temperature water source.

69. (WITHDRAWN) The chemical process system of claim 67, wherein the compressive medium includes an inert medium.

70. (WITHDRAWN) The chemical process system of claim 67, wherein the first chemical reactor accommodates a throughput of between 100 liters per hour to approximately 10,000 liters per hour.

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71. (WITHDRAWN) The chemical process system of claim 67, further comprising a vent valve in fluid communication with the pressure vessel.

72. (WITHDRAWN) The chemical process system of claim 67, further comprising a controller operatively coupled to sensors associated with the pressure vessel and the first chemical reactor, wherein the controller is operative to maintain an internal pressure within the pressure vessel to be greater than an internal pressure within the first chemical reactor.

73. (WITHDRAWN) The chemical process system of claim 67, further comprising a purge stream providing selective fluid communication between an interior of the pressure vessel and an interior of the first chemical reactor.

74. (WITHDRAWN) The chemical process system of claim 67, further comprising a recycle stream for cycling the compressive medium into and out of the pressure vessel, wherein a heat exchanger is in thermal communication with the recycle stream.

75. (WITHDRAWN) The chemical process system of claim 67, further comprising:
a first heat exchanger comprising microchannels in fluid communication with the microchannels of the first chemical reactor;
a second heat exchanger comprising microchannels in fluid communication with the microchannels of the second chemical reactor;
at least a portion of the microchannels of the first heat exchanger are housed within the pressure vessel; and
at least a portion of the microchannels of the second heat exchanger are housed within the pressure vessel.

76. (WITHDRAWN) The chemical process system of claim 75, wherein:
at least one of the microchannels of the first heat exchanger is adjacent to at least one of the microchannels of the second heat exchanger;

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the at least one microchannel of the first heat exchanger is adapted to carry a first fluid therein in a first direction; and

the at least one microchannel of the second heat exchanger is adapted to carry a second fluid therein in a second direction.

77. (WITHDRAWN) The chemical process system of claim 76, wherein the first fluid has a higher thermal energy content than the second fluid.

78. (WITHDRAWN) The chemical process system of claim 76, wherein:
the first fluid includes a product from an exothermic reaction; and
the second fluid includes a reactant for an endothermic reaction.

79. (WITHDRAWN) The chemical process system of claim 76, wherein:
the first fluid includes a product from an exothermic reaction; and
the second fluid includes a reactant for an exothermic reaction.

80. (WITHDRAWN) The chemical process system of claim 17, wherein:
the first unit operation includes a chemical process conduit including microchannels adapted to be in fluid communication with a chemical process stream; and
the pressure vessel contains at least a portion of the chemical process conduit..

81. (WITHDRAWN) The chemical process system of claim 80, further comprising a process conduit in thermal communication with the chemical process conduit and in fluid communication with a process conduit stream.

82. (WITHDRAWN) The chemical process system of claim 81, wherein:
a first reaction occurs within the microchannels of the chemical process conduit;
and
the chemical process stream is adapted to be in fluid communication with a reactant supply stream and a product stream.

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83. (WITHDRAWN) The chemical process system of claim 82, wherein:

the process conduit includes microchannels;

a second reaction occurs within the microchannels of the process conduit; and

the process conduit stream is adapted to be in fluid communication with a second reactant supply stream and a second product stream;

84. (WITHDRAWN) The chemical process system of claim 83, further comprising a heat exchange recuperator adapted to exchange thermal energy with at least one of the reactant supply stream, the product stream, the second reactant supply stream, and the second product stream.

85. (WITHDRAWN) The chemical process system of claim 84, wherein the heat exchange recuperator includes microchannels.

86. (WITHDRAWN) The chemical process system of claim 85, wherein the heat exchange recuperator is at least partially contained within the pressure vessel.

87. (WITHDRAWN) The chemical process system of claim 86, wherein:

the microchannels of the chemical process stream are wholly contained within the pressure vessel;

the microchannels of the process conduit are wholly contained within the pressure vessel; and

the microchannels of the heat exchange recuperator are wholly contained within the pressure vessel.

88. (WITHDRAWN) The chemical process system of claim 80, wherein the compressed medium contained within the pressure vessel includes an inert medium.

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89. (WITHDRAWN) The chemical process system of claim 83, wherein the compressed medium contained within the pressure vessel includes a reactant from at least one of the reactant supply stream and the second reactant supply stream.

90. (WITHDRAWN) The chemical process system of claim 83, wherein the compressed medium contained within the pressurized vessel includes a product from at least one of the product stream and the second product stream.

91-96. (CANCELLED)